REMARKS

By the present amendment, independent claim 1 has been amended to correct an apparent typographical error. In addition, independent claim 1 has been amended to incorporate the subject matter of dependent claims 6 and 7. Claims 6 and 7 as well as claim 31 have been deleted. In addition, the preambles of all of the claims have been amended to modify the recitation "flame-sprayed copper-aluminum composite material" to "a sliding layer of a sliding member, consisting of flame-sprayed copper-aluminum composite material." Claims 1-5, 8-30 and 32-38 now are pending.

It is submitted that these amendments to the claims are helpful in distinguishing the subject claims over the cited prior art and do not raise new issues which would require further consideration and/or search. In addition, it is submitted that such amendments place the application in better form for appeal by materially reducing or simplifying the issues for appeal. Furthermore, no additional claims are presented without cancelling a corresponding number of finally rejected claims. In view of the above, it is submitted that entry of the above amendments is in order and such is respectfully requested.

In the Action, an apparent typographical error in connection with the term "alloy" as contained in claim 1 was noted. As mentioned above, the term in this claim has been corrected herein.

Claims 1-38 were rejected under 35 USC § 103(a) as being unpatentable over the patent to Kawagoe et al in view of the patent to Terada et al in view of the patent to Nakagawa et al. As before, it basically was asserted in making this rejection that the cited Kawagoe et al patent teaches flame-sprayed copper based compositions with ranges for disclosed components overlapping those as claimed. Further, it was alleged that each patent teaches to selectively melt or unmelt alloying elements. However, it was acknowledged that the Kawagoe et al patent does not teach feeding the copper and the aluminum separately, but it was alleged that the Terada et al patent as well as the cited patent to Nakagawa et al supply this deficiency since they each teach use of mixtures of particles for flame spraying to produce alloys. Reconsideration of this rejection in view of the above claim amendments and the following comments is respectfully requested.

Before discussing the rejection in detail, a brief review of the presently claimed invention may be quite instructive. An important feature of the presently claimed invention is that a novel sliding layer of a flame-sprayed material which is used for a sliding member is provided. As is presently claimed, the flame-sprayed copper-aluminum composite material of the sliding layer comprises a first copper alloy having at least an unmelted phase, and a first aluminum alloy having at least a melted phase, formed by flame-spraying an aluminum-alloy powder and a copper alloy powder. The first copper alloy comprises 40% by weight or less of Pb, and the first aluminum alloy comprises from 10 to 60% by weight of Si.

In the subject flame-sprayed copper-aluminum composite material, the simultaneous presence of the Cu and Al phases is attained by separate spraying of a Cu alloy powder and an Al alloy powder under controlled melting and solidification of these powders. The melting and solidification are controlled in such a manner that the alloying elements, e.g., Si and Pb, and the main elements, i.e., Cu and Al, form the micro-structure of a first copper alloy having at least an unmelted phase, and a first aluminum alloy having at least a melted phase. The melting and solidification process is completed in a time period shorter than 1 second. Mere separate spraying mentioned above cannot control the melting and solidification process in a time period shorter than 1 second.

In the copper alloy portion of the flame-sprayed composite material, Pb is finely dispersed, because at least part of the copper alloy remains unmelted during spraying. The fine Pb phase melts during sliding of the sliding member, decreases the coefficient of friction and forms a thin film, thereby preventing the sliding material from adhering to a material of the opposite sliding member. Thus, adhesive wear is prevented. Further, the copper alloy has good seizure resistance under poor oil-lubrication conditions.

In distinct contrast, if the copper phase is totally melted during the spraying, Pb is dissolved in the Cu phase and cannot realize the advantageous functions as described above. In addition, the Cu-phase in which Pb is dissolved may peel in the form of fine

fragments during sliding of the sliding member.

In the Al-Si alloy portion of the flame-sprayed composite material, the relatively large or coarse Si primary crystals are dispersed in an Al-Si eutectic structure and these crystals impart the Al-Si alloy with high wear resistance under relatively good lubricating conditions. Adhesion between the coarse Si particles and the metal of opposite sliding member is poor. Furthermore, the coarse Si particles are of high strength. The coarse Si particles, therefore, support the load of the opposite member and helps the sliding member attain good wear resistance and seizure resistance. However, the aluminum of the Al-Si alloy has poor wear resistance under poor lubricating conditions.

In summary, the sliding layer of a sliding member consisting of a flame-sprayed copper-aluminum composite material according to the present invention takes advantage of the features of both the copper alloy and the aluminum alloy, while the disadvantages of these alloys are not apparent in the sliding layer of the present invention. It is submitted that the cited patents to Kawagoe et al, Terada et al, and Nakagawa et al, whether taken singly or in combination, do not teach or suggest the presently claimed invention.

The Kawagoe et al patent teaches a swash plate having a flame sprayed layer of copper-based alloy which contains 0.5 to 50% of one or more of not more than 40% of lead, not more than 30% of tin, not more than 0.5 of phosphorous, not more than 15%

aluminum, not more than 10% of silver, not more than 5% of silicon, nor more than 5% of manganese, not more than 5% of chromium, not more than 20% of nickel, and not more than 30% of zinc. Among other things, the Kawagoe et al patent does not teach or suggest the simultaneous spraying of Cu alloy powder and Al alloy powder, because the patent discloses that a coarse Cu alloy powder and a fine Cu alloy powder are thermally sprayed to form the melted and unmelted structures. It is submitted that these teaching deficiencies are not supplied by the patents to Terada et al and Nakagawa et al.

The Terada et al patent discloses a brazable aluminum material composed of a core of aluminum and a brazing agent layer consisting of a brazing agent thermally sprayed onto a surface of the core. The brazing agent sprayed onto the core is an Al-Si alloy and/or a mixture of Al powder and Si powder and a number of unmelted particles of brazing agent are present in the brazing agent layer. Therefore, four phases, i.e., a melted Al phase, an unmelted Al phase, a melted Si phase, and unmelted Si phase, may be present in the brazable aluminum material according to the Terada et al patent. Thus, among other things, the Terada et al patent relates to a brazing material, not to a sliding layer of a sliding member, consisting of flame-sprayed copper-aluminum composite material as presently claimed. Further, the Terada et al patent does not teach or suggest the simultaneous spraying of Cu alloy powder and Al alloy powder, because only the Al powder is thermally sprayed to form the melted and unmelted structure.

The Nakagawa et al patent discloses a thermal spray coating material which comprises 98-70 vol.% of Cu-based bronze and 2-30 vol.% of Al or Al alloy. The thermally sprayed Al (alloy) powder and the Cu-based bronze powder are melted and blown onto the base material. It is suggested that all of the flame sprayed materials should be melted, since it is specifically taught that unmelted powder is not preferable as stated on column 5, lines 55-60. Therefore, the Nakagawa et al patent does not disclose the microstructure of a sliding layer of a sliding member as claimed which has an unmelted Cu alloy phase as well as melted Al alloy phase. That is, the Nakagawa et al patent does not teach to selectively leave the Cu alloy particles unmelted, thereby finely dispersing the Pb phase.

It is submitted that it is not a mere matter of choice of well known forms to leave the Cu alloy unmelted in flame spraying for the reasons set forth above in describing the presently claimed invention. That is, if the Cu-Pb alloy is melted, the Pb dissolves and does not form fine Pb particles. If the Al-Si alloy powder having fine Si primary crystals is unmelted, these crystals will not adequately support the load of the opposite sliding member and adhesion between aluminum and opposite sliding member is likely to occur.

In this regard, specific attention is directed to Examples 1 through 7 according to the present invention as compared with Comparative Examples 1 and 2 as set forth in Table 3 of the present specification. In Comparative Example 1, only a Cu alloy powder is flame-sprayed by the method as set forth in Example 1. A partly unmelted Cu phase is therefore

formed. In Comparative Example 2, only Al alloy powder is flame-sprayed and is therefore melted. The wear amounts for the Comparative Examples shown in Table 3 are very high. Therefore, it would be reasonable for a person of ordinary skill in the art to project from these results that, when Comparative Examples 1 and 2 are simultaneously carried out, an intermediate wear amount, i.e., about 70 μm, would be attained. Unexpectedly and surprisingly, the wear amounts of Examples 1 through 7 according to the presently claimed invention are considerably lower than about 70 μm. Thus, the composite material for a sliding layer for a sliding member according to the presently claimed invention, in which the flame-spraying of the two Comparative Examples 1 and 2 are simultaneously conducted, attains a synergistically improved wear resistance as compared with either of these Comparative Examples alone.

It was asserted in the Action that the subject claims are product claims and that process limitation therein do not contribute to patentability, that is, the simultaneous spraying of the Cu powder and Al powder does not contribute to the patentability of the product claim. However, as is explained in detail above, an important feature of the presently claimed product is the simultaneous presence of the unmelted Cu phase and melted Al phase. In this context, the Nakagawa et al patent relates to a sliding layer consisting of a flame-sprayed Cu-Al alloy. However, the concept of generating the sliding property according to the present invention is different from that of the Nakagawa et al patent and the properties of the subject sliding member are different from that of the

patent.

In summary, it is submitted that a sliding layer of a sliding member, consisting of flame-sprayed copper-aluminum composite material having the simultaneous presence of an unmelted Cu alloy phase and melted Al phase is not taught or suggested by any of the cited patents. Thus, consideration should not be concentrated on the process feature of the invention, i.e., simultaneous spraying, but rather attention should be directed to the product feature as set forth in the present claims and as outlined above. Consequently, if the above rejection is adhered to, it is respectfully requested that specific reasons be set forth as to the manner in which the cited patents render obvious the above concept of the simultaneous presence of an unmelted Cu alloy phase and melted Al phase in a flame-sprayed copper-aluminum composite material of a sliding layer of a sliding member.

For the reasons stated above, withdrawal of the rejection under 35 U.S.C. § 103(a) and allowance of claims 1-5, 8-30 and 32-38 as amended over the cited patents are respectfully requested.

In view of the foregoing, it is submitted that the subject application is now in condition for allowance and early notice to that effect is earnestly solicited.

In the event this paper is not timely filed, the undersigned hereby petitions for an appropriate extension of time. The fee for this extension may be charged to Deposit Account No. 01-2340, along with any other additional fees which may be required with respect to this paper.

Respectfully submitted,

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